widely, and these researchers have conflicting interpretations of the data. This is not surprising, since the indexes of output used are highly collinear, and it is not possible to econometrically determine the impact of each index on cost. As noted elsewhere,[27] the collinearity of the variables produces meaningless (negative) estimates of marginal costs for some observations within the samples used for the analysis. This also implies that the estimated cost elasticities are unreliable; hence these models are not of value in determining the relationship between output growth and TFP growth.

In conclusion, recent econometric literature supports the conclusion first reached by Caves and Christensen, namely, that the telephone industry has significant economies of density, and suggests that the magnitude of the impact may even be greater than that estimated by Caves and Christensen. This evidence also shows that economies of density exist for the LECs. Using the more conservative Caves and Christensen results, a one percentage point decrease in output will lead to a reduction in TFP growth of between .3 and .5 percentage points. Over the post-divestiture period, the LECs have been able to achieve TFP growth of 2.6 percent with output growth of 3.5 percent. If future LEC output growth were to be a full percent lower, 2.5 percent, then these econometric studies indicate that TFP growth would be in the 2.1 percent to 2.3 percent range, reducing the TFP growth differential between the LECs and the overall private business sector to the 1.2 percent to 1.4 percent range.

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[27]Leonard Waverman, "U.S. Interexchange Competition," in R.W. Crandall and K. Flamm, eds., Changing the Rules: Technological Change, International Competition, and Regulation in Communications, (Washington, DC, Brookings, 1989), p. 91.

2.4 The Impact of Toll and Switched Access Output Growth on TFP Growth

The econometric studies reviewed in the previous section focus on the overall relationship between output growth and TFP growth, looking at historical trends. They do not address the impact of output growth reductions that occur exclusively in markets where the services have relatively high contributions to joint and common costs (i.e., low marginal costs relative to price).

As discussed in Section 2.2, services that have relatively high contributions to joint and common costs can make substantial contributions to TFP growth. As output grows in these services, total revenue increases more rapidly than total cost. In "real" terms, total output also increases faster than total input. Conversely, a reduction in the rate of growth of output of these services will lead to a reduction in the TFP growth rate.

Two areas with the potential for future reductions in the rate of output growth that also have relatively high contribution margins are intra-LATA toll and switched access. The Local Exchange Carriers are facing increasing competition in both areas, and the LECs are faced with the prospect that future output growth in these areas will be less than historical growth, as competing firms take business away from them.

Equation (2.5) can be used to analyze the impact on TFP growth due to reductions in output growth for these two services. This requires information on cost elasticities of output (ϵ_i) and revenue shares (m_i) for these services. Recently Calvin

Monson and Jeffrey Rohlfs[28] reviewed the evidence on the incremental cost of intra-LATA toll and switched access. They concluded that the long-run incremental cost of these services was no greater than $8.9 billion for the Local Exchange Carriers.[29] To convert the incremental cost to a cost elasticity, one must estimate total economic cost for the LECs. Total economic cost is roughly equal to total revenue; total revenue in 1991 (the year of the Monson-Rohlfs analysis) was $86.5 billion. This implies that the cost elasticity of output of intra-LATA and switched access services is approximately .10. On the other hand, the revenue share of these services in 1991 was .31.

Referring back to equation (2.5), one can see that a one percentage point decrease in the rate of growth for intra-LATA toll and switched access will lead to approximately a .21 percentage point decrease in TFP (i.e., $m_i - \epsilon_i = .21$). Historically, the rate of growth in output for these services has averaged 5.7 percent. It is possible that competition will lower this average rate of growth for the LECs in the future. For example, if the annual average rate of growth were to drop by one percentage point to 4.7 percent, this would reduce the rate of TFP growth from 2.6

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[28]"The $20 Billion Impact of Local Competition in Telecommunications," Strategic Policy Research, July 1993.

[29]The Monson-Rohlfs study evaluated three analyses of incremental cost: Bridger Mitchell, Incremental Costs of Telephone Access and Local Use, Santa Monica, The RAND Corporation, 1990; Lewis J. Perl and Jonathan Falk, "The Use of Econometric Analysis in Estimating Marginal Cost," presented at the Bellcore and Bell Canada Industry Forum, San Diego, California, April 1989; and Michael J. Marcus and Thomas C. Spavins, "The Impact of Technical Change on the Structure of the Local Exchange and the Pricing of Exchange Access: An Interim Assessment," unpublished draft.

percent to 2.4 percent, all else equal. This would lower the TFP growth differential between the LECs and the private business sector to 1.5 percent. Similarly, if the output rate of growth for these services were reduced by two percentage points to 3.7 percent, TFP growth would be reduced to 2.2 percent, and the differential would be reduced to 1.3 percent.

Appendix 1

Use of a Revenue Weighted TFP Index for Purposes of Constructing a Price Cap Index

Our LEC TFP study uses a revenue weighted Tornqvist total output quantity index. While marginal cost weighted indexes are appropriate for some other applications, the revenue weighted index is proper when evaluating a price cap index. The reason that a revenue weighted index is proper is that it is "dual" to the customer's price index of telephone rates. The use of the revenue weighted output index allows one to relate increases in output price to changes in input price and changes in TFP. In the following paragraphs we demonstrate this principle mathematically.

First we define total revenue to be R and total cost to be C. Total revenue is related to the prices and quantities of output by the following equation:

$$R = \Sigma P_i \cdot Y_i \qquad \text{(A1)}$$

where

P_i = the price of output i
Y_i = the quantity of output i.

Similarly, total cost is related to the prices and quantities of the inputs used:

$$C = \Sigma W_j \cdot X_j \qquad \text{(A2)}$$

where

W_j = the price of input j
X_j = the quantity of input j.

Equation (A1) can be converted into an equation representing rates of change in revenue, output prices, and output quantities:

$$r = \Sigma\, m_i \cdot p_i + \Sigma\, m_i \cdot y_i \qquad \text{(A3)}$$

where

r = growth in revenues
p_i = growth in output price i
y_i = growth in output quantity i
m_i = the revenue share of output i.

Equation (A2) can similarly be converted into an equation relating the rate of change in total cost to the rate of change in input prices and quantities:

$$c = \Sigma\, s_j \cdot w_j + \Sigma\, s_i \cdot x_j \qquad \text{(A4)}$$

where

c = change in total cost
w_j = change in input price j
x_j = change in input quantity j
s_j = the cost share of input j.

In market equilibrium, as competitive forces constrain firms to earn only a normal profit, the rate of change in revenue equals the rate of change in cost. Thus combining equations (A3) and (A4), one obtains:

$$\Sigma\, m_i \cdot p_i = \Sigma\, s_j \cdot w_j - \{\, \Sigma\, m_i \cdot y_i - \Sigma\, s_j \cdot x_j \,\} \qquad \text{(A5)}$$

$$= \Sigma\, s_j \cdot w_j - tfp$$

where

tfp = the rate of growth in TFP.

This means that the rate of change in output prices equals the rate of change in input prices less the rate of change in total factor productivity.

Appendix 2

Output Price Index Calculations

Price indexes for local service, long distance service, and intrastate access service are constructed from rate change information contained in the Form M report. In the Form M, the LECs report the impact of rate changes in terms of changes in revenue. The methodology we use converts the dollar change in revenue to a percentage change in the overall rate level. The percentage changes in rate level are then converted to a price index. In order to apply the methodology to the Form M data, one must determine the following for each reported rate change: (1) the service category (i.e. local, long distance, intrastate access, or other) affected by the rate change; and (2) whether the rate change is a permanent rate change or a temporary surcharge or credit. The following steps describe the construction of the price indexes.

Step 1. Determine the Annualized Value of Permanent Rate Changes and the Effective Value of Permanent Rate Changes in the First Year. The data provided in the Form M are stated in terms of the annualized value of each rate change. Thus when the Form M reports a local rate increase of $20 million, this means that with no change in quantities, the rate change will increase revenue annually by $20 million. However, if a rate change is not initiated at the beginning of the year (January 1), booked revenue for that year will only reflect a portion of the annualized value, since the new rate was not in effect for the full year. Since the price indexes we are

constructing are intended to represent the average price level for the year, the effective value of the rate change in the first year must be calculated. The effective value is equal to the annual value times the fraction of the year that the new rate was in effect.

For example, if the $20 million rate change goes into effect halfway through the year (July 1), the effective value will be $10 million, and this will be the magnitude of the rate impact on booked revenue during the first calendar year. During the second calendar year, booked revenue will reflect the full $20 million rate change. In order to construct a price index that correctly converts booked revenue to quantities, the price index must incorporate the effective value of the rate change in the first calendar year, then incorporate the remaining amount of the annualized value in the second calendar year.

For each service, the annualized and effective values are computed for each rate change, and are summed to a total annualized value and total effective value for each year in the study. We define A_t to be the annualized value of the rate change and E_t the effective value.

Step 2. Calculate Net Credits for Each Year. One time credits and surcharges are different than permanent rate changes in that they have only a temporary impact on the price level. Using the Form M data on one time credits and surcharges, we calculate total credits net of surcharges. We define C_t to be net credits.

Step 3. Tabulate the Reported Revenue for Each Year. In order to convert a service category's effective and annualized values of rate changes into percentage changes in rates, they must be divided by that category's total revenue. Thus booked revenue is collected for local service and billed revenue for long distance and intrastate access. (See Section 1.1 for a discussion of why billed revenue is used for long distance and intrastate access.) We define R_t to be reported revenue.

Step 4. Compute the Percentage Change in the Price Level for Year t. The change in the average price level for year t, relative to the price level in year t-1, is determined by three factors: (1) net credits effective for the year; (2) the effective value of any rate changes that occur during the year; and (3) any carryover from the previous year's rate changes (i.e., the difference between the previous year's annualized value of rate changes and effective value of rate changes). The following formula incorporates these three factors:

$$P_t/P_{t-1} = [(R_t/(R_t - C_t))/(R_{t-1}/(R_{t-1} - C_{t-1}))]$$
$$\cdot R_t / \{R_t - E_t - [(A_{t-1} - E_{t-1})\cdot(R_t/R_{t-1})]\}$$

where

P_t = price level in year t
R_t = reported revenue in year t
C_t = net credits in year t
E_t = effective value of rate change in year t
A_t = annualized value of rate change in year t.

Once the change in the price level is computed for each year of the study, an index of annual rate levels can be computed by initializing the index at 1.0 in 1984. The index level for each subsequent year is based on the percentage change in the price level for that year over the previous year.

ATTACHMENT 7

The Economic Impact of Revising the Interstate Price Cap Formula for the Local Exchange Companies

by

The WEFA Group

THE ECONOMIC IMPACT OF REVISING THE INTERSTATE PRICE CAP FORMULA FOR THE LOCAL EXCHANGE CARRIERS

INTRODUCTION AND SUMMARY

The WEFA Group has completed an economic impact analysis of revising the interstate price cap formula for the local exchange carriers (LECs). The study utilizes WEFA's integrated and consistent large-scale econometric models of U.S. macroeconomic and industry economic activity. The analysis incorporates carefully researched assumptions regarding the expected future course of the telecommunications services industry under the current price cap regime and under an alternative, revised price cap regime proposed by USTA.[1] The difference between the two environments leads to changes in industry investment, service quality, and the rate of economy-wide technology implementation. These changes are factored into WEFA's models to simulate the impacts of this regulatory change throughout the economy over the next ten years.

The enhanced models yield two sets of forecasts through the year 2004. The first forecast represents WEFA's standard long-term forecast of economic activity in the United States. (This is referred to as the Baseline forecast throughout the report.) In WEFA's Baseline forecast, the economy grows steadily in real terms through 2004. During the first three years of the forecast, growth averages 3.2% per year. Thereafter, growth averages 2.6% per year. Total real Gross Domestic Product (GDP) exceeds $8.7 trillion in constant 1994 dollars by 2004.

The second forecast quantifies the impact of implementing a revised price cap formula for the LECs. (This is referred to as the Revised Price Cap simulation throughout the report.) In the Revised Price Cap simulation, the revised price cap formula offers greater pricing flexibility and earnings incentives. This provides incentives for the LECs to accelerate investment and, thereby, improve service quality at a faster pace. In response, businesses and households adopt enhanced telecommunication services sooner than in the Baseline forecast, yielding a slightly faster rate of technological change over the forecast period. The acceleration in enhanced telecommunications technology deployment and service quality result in an increased use of telecommunications services by all sectors of the economy, leading to increases in the rate of technological change and productivity. As a result, the economy grows slightly faster than in the Baseline forecast. Total real GDP reaches $8.8 trillion in constant 1994 dollars by 2004, surpassing the Baseline forecast by $60.5 billion in 2004. The total cumulative gain is $278 billion over the next ten years.

The key results are summarized below and explained more completely in the report.

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[1]USTA proposes that profit sharing/low-end adjustment mechanism be eliminated, that codification of all access rate elements except public policy be eliminated, that increased pricing flexibility be afforded for competitive markets, that new service pricing rules be simplified, that the LEC productivity factor should be based on TFP, that the Common Line Adjustment Formula is not necessary, that exogenous cost eligibility should not be narrowed, and that LECs should be afforded equal treatment with competitors.

Employment

With the revised price cap formula, the economy gains 510,000 additional jobs over the next ten years. The additional jobs are spread throughout the economy, with all major industry groups participating in the benefits. The broad services sector gains the largest number of jobs due to the availability of enhanced, broadband telecommunication services.

Gross Domestic Product

The new regulatory environment adds $60.5 billion to total real gross domestic product in 2004 compared to the Baseline forecast. Over the entire ten year interval, the cumulative gain in real GDP totals $278 billion.

Among the major components of GDP: personal consumption gains $148 billion cumulatively over the next ten years and ends the decade $30.3 billion higher; business fixed investment gains $69 billion cumulatively over the next ten years and ends the decade $14.2 billion higher; residential investment gains $28 billion cumulatively over the next ten years and ends the decade $6.6 billion higher; exports gain $28 billion cumulatively while imports gain only $12 billion cumulatively over the next ten years resulting in a cumulative improvement in the balance of trade over the next ten years. The federal budget deficit improves $149 billion cumulatively over the next ten years and ends the decade $33 billion better off.

Consumer Benefits

Due to the efficiencies and cost reductions throughout the economy, the annual rate of inflation (as measured by the Gross Domestic Product deflator) is 0.15 of a percentage point lower on average per year over the next ten years. In total, the price level is 1.4% lower in the Revised Price Cap simulation than in the Baseline forecast by 2004. Consumer price inflation sheds 0.18 of a percentage point on average per year over the next ten years.

As a result of lower inflation, consumers save $136 billion on total consumer expenditures in 2004. Cumulatively, the total savings on total consumer expenditures over ten years is $582 billion. At the same time, real disposable income is $30 billion higher in 2004 than in the Baseline forecast. Cumulatively, the economy generates a total of $145 billion in additional real disposable income over the next ten years.

OBJECTIVE

The primary objective of this study is to estimate and forecast the direct and indirect economic impacts in the U.S. due to the implementation of a revised price cap formula in 1995. In particular, the study:

- Takes a comprehensive, consistent, and dynamic view of the economic environment by using WEFA's U.S. Economic Model and Industry Analysis Model.

- Utilizes an integrated approach that combines the expertise of well-known experts and analysts in the telecommunications industry with WEFA's time-tested modeling expertise.

- Combines the synergistic gains across all communications and information technology activities.

- Uses the relationships between the communications and information technology industries and their major markets and suppliers to track the ripples of change throughout the economy.

- Quantifies the total dynamic economic impact throughout the economy due to the use of a revised price cap formula not merely the isolated changes expected in the telecommunications industry.

- Compares the Revised Price Cap simulation to WEFA's standard long-term Baseline forecast.

ANALYTICAL APPROACH

WEFA's modeling infrastructure provides the framework with which to develop a comprehensive, consistent, and accurate view of changes in economic conditions, industry structure, and aggregate price change by industry resulting from changes in external factors. In this study, the external factor is the revised price cap formula for the LECs. For comparison purposes, WEFA's Baseline forecast provides a long-term view of economic activity over the next ten years under normal conditions. The Baseline forecast includes a view of the U.S. economy at the national level and an integrated view of business activity for selected industries.

WEFA's U.S. Economic Model is a quarterly econometric model of the national economy. It is designed for forecasting, policy analysis, and simulation studies. The model is used every month by economists at WEFA to generate a baseline forecast of the U.S. economy and to provide alternative forecasts based on varying assumptions on government policies and other factors. Many of WEFA's clients use this model in their own planning and forecasting activities.

The U.S. Economic Model is directly linked to WEFA's Industry Analysis Model to provide a more robust environment in which to estimate and forecast the impacts of changes in specific industries on other industries and on the economy in general. The Industry Analysis Model quantifies the size, growth, and relationships of 117 industries in the U.S. economy. It enables careful estimation of the contributions of each industry to the economy and the effects on each industry from changes in key economic factors. Thus, it provides both a supply-side view and a demand-side view of each industry, and it translates macroeconomic forecasts into demand for goods and services by industry.

The research and analysis undertaken for this and other WEFA studies on the telecommunications industry has led to a number of general expectations about the future course of the telecommunications services industry. These include:

- Competition in telecommunications services and markets will increase significantly, maintaining downward pressure on real service prices, improving service quality, and accelerating the availability of new telecommunications services, information services, and telecommunications equipment to all customer segments.

- The "time value of information" and lower average real prices will accelerate the adoption of enhanced services and equipment by more and more businesses and consumers.

- Economy-wide productivity improves due to the increased utilization of a more efficient, more capable network and the availability of enhanced services.

- The tremendous capacities associated with new digital technologies will represent a genuine paradigm shift from past bandwidth-limited technologies.

- As convergence progresses, the LECs, other service providers, equipment manufacturers, software developers, and entrepreneurs will jointly develop some of the linkages between

the public telecommunications network and the many extensions into other business activities throughout the economy.

These general assumptions, with supporting input from other experts, lead to three specific modeling assumptions:

- First, based on more pricing flexibility and earnings incentives, the LECs have greater financial incentives to increase investment and deploy enhanced technologies sooner. Existing and potential competitors increase their investment as well, leap-frogging advances in technology ensue. More pricing flexibility and earnings incentives enable the LECs and other communications service providers to deploy more quickly and inexpensively a new, intelligent, public network infrastructure. In total, the telecommunications industry increases their investment in the infrastructure at an increasing rate over the next ten years. The Revised Price Cap simulation assumes that investment spending is 5% higher in 1995 and that the increment to investment spending increases gradually to 15% in 2004.

- Second, driven by enhancements in the public network, quality improvements in the available and adopted telecommunication services average 1% more than the Baseline in 1995 and increase steadily to 3% more than the Baseline in 2004.

- Third, the rate of economy-wide technological change and technology implementation averages 0.01% higher per year from 1995 through 2004 as competition improves available services, more businesses and households utilize enhanced technologies, and threats from abroad resume as a rolling worldwide recovery commences.

These assumptions are believed to be conservative given the speed with which new applications and processes could be developed and adopted when an enhanced, broadband network becomes available. More rapid application development and adoption could easily yield more rapid gains in telecommunication and information services quality which could yield even greater benefits to telecommunications service, telecommunications equipment, and information technology users than assumed in this study.

The analysis undertaken to quantify the economic impact of revising the price cap formula for the LECs is similar to the analysis undertaken for AT&T in 1987. However, there are several important differences that reflect changes in WEFA's models, the approach taken in the analysis, and the scale of the issue being examined.

First, the models have been updated and enhanced. The update process is ongoing. It assures WEFA's clients that all recently compiled data on economic conditions and interindustry relationships are incorporated into the models and the forecasts. During the last six years, publicly available data and private-sourced studies have provided important evidence on the effects of information technology in the work place. The course of the recession and slow recovery has revealed major changes in the white collar and middle management ranks. The data that help define and understand these changes improve the economic forecasts.

The models have also been enhanced. The number of industries has been expanded from 57 used in the 1987 study to 117 used in the current study. The additional detail more accurately traces the economic linkages across industries, yielding a more complete and reliable quantification of economic impacts in a study such as this.

Second, the approach in the current study is more complete than the 1987 study. Three key factors -- telecommunications industry investment, telecommunications service quality, and economy-wide technological change -- are included in this study to more realistically examine the economic impact of a price cap revision for the LECs. The expected acceleration in industry investment yields an enhanced public telecommunications network that improves currently available services and supports valuable new services. As a result, telecommunications services are more intensively used in the future, increasing efficiency and quality in many processes. The slight acceleration in the economy-wide rate of technological changes also nudges economy-wide productivity upward.

Third, revising the price cap formula for the LECs will have a broader and deeper effect than a comparable adjustment for the IXCs. Competition will lead to a more rapid deployment of digital switching and broadband technologies that enhance services well beyond the local loop. The entire network and all users benefit.

REVISED PRICE CAP SIMULATION ASSUMPTIONS

The economic impact analysis relies on three assumptions that are programmed into WEFA's U.S. Economic and Industry Analysis models. In general, pricing flexibility and earnings incentives under a new price cap formula lead to greater investment in the public network. These investments enhance service quality and create greater value for telecommunication service users. Users respond to higher quality by investing in specific equipment to take advantage of the efficiencies and opportunities afforded by more useful applications.

Given the demographic characteristics that shape the long-term potential growth path of total output, the U.S. economy can utilize the efficiencies that an enhanced telecommunications network and improved services can provide. The maturation of the nation's labor force, the knowledge base of the workers, the deceleration of new entrants into the work force, and the large and growing installed base of more and more capable personal computer systems create an environment over the next ten years in which employers will need more efficient processes to expand output. The expected increase in the capital-labor ratio during the next decade works toward this goal. A more sophisticated telecommunications network will enable employers to more fully utilize the growing force of remote site workers and expand the labor force.

This section of the report discusses the assumptions factored into WEFA's models.

Investment

The investment assumption is based on the expectation that price cap reform will yield more pricing flexibility and earnings incentives. The LECs and ultimately all viable competitors in the telecommunications industry will respond to competitive pricing pressure with service enhancements that create a competitive advantage. These enhancements initially take the form of increased investment in the public telephone network (PTN).

As Darby indicates in his report, management will answer several fundamental financial questions.

- How much should the firm invest?
- What projects should be undertaken?
- How should the investment program be funded?

The answers to these questions require that choices be made on the use of earnings. To the extent that earnings are used to enhance the network, limits are placed on dividends to share holders. But this is a balancing act that postpones short-term payments for longer-term growth and potential higher payments.

In his research, Darby has estimated that the telecommunications industry is likely to spend an additional 5% to 15% per year of its planned investment over the next ten years to enhance the PTN. This will occur as some firms initially try to gain a competitive advantage over other firms in the industry and the other firms respond to assure their viability in the market.

WEFA's Baseline economic forecast contains real telecommunications industry investment that grows from $25.2 billion in 1994 to $33.9 billion in 2004. This represents a compound annual growth rate of 3.0%. Over the ten-year interval from 1984 through 1994, real telecommunications industry investment increased at a compound annual growth rate of 0.4%. Thus, even in the Baseline forecast, investment in the PTN grows significantly during the forecast period relative to the past decade. There are a number of reasons for this improvement including:

- Advances in technology and the relatively low cost of deploying the new technologies create competitive pressures that induce additional investments to provide better, higher value services.

- Telecommunications equipment and services are catching up with the advances in computer hardware and software technologies and the increasingly useful applications that include data and information transmissions from one geographic location to another.

Investment in the telecommunications sector stimulates additional investment in information technology among users. In the information technology triad (that is, computer hardware, computer software, and telecommunications) the telecommunications component has lagged the tremendous strides made in the other two over the last ten years. The amount of processing power and the accessibility of this capability on desks, in offices, and in homes has significantly increased the usefulness of data and information. However, the speed with which the information is typically transmitted from one point to another is slow. Small batches of data can be sent anywhere, but large data files and images are severely limited by low throughput rates on the network.

Table 1
Total Telecommunications Industry Investment
Increases in the Revised Price Capital Simulation

Year	Billions Current $	Billions Constant $
1995	1.6	1.3
1996	2.1	1.7
1997	2.6	2.1
1998	3.2	2.5
1999	3.7	2.9
2000	4.3	3.3
2001	5.0	3.7
2002	5.7	4.1
2003	6.5	4.6
2004	7.3	5.1

As Table 1 shows, under a revised price cap regulatory environment, total real telecommunications industry investment is expected to increase an additional 5% in 1995 up to an additional 15% in 2004. Thus, in real terms, total investment increases $1.3 billion in 1995 and $5.1 billion in 2004 over the Baseline forecast. The total cumulative additional investment exceeds $30 billion over the next ten years. The compound annual rate of growth in total telecommunications investment in the Revised Price Cap simulation is 4.5% over the next ten years, representing a significant improvement over the Baseline forecast.

Service Quality

Improvements in service quality result from the increased investment in the PTN. The additional investment will dramatically increase the penetration curves of digital and broadband technologies. Both the availability and adoption of new technologies are accelerated in the Revised Price Cap simulation. The increase in quality, especially the speed of transmission, creates greater value for the users. Ultimately, the end users experience a reduction in the cost per unit of service purchased.

Technology Futures, Inc. (TFI) presents detailed projections of the expected availability and adoption of ISDN digital capabilities and even more advanced broadband equipment and services. In their analysis, the availability of ISDN (narrowband) services increases from 43% in 2004 in the Baseline forecast to 94% in the Revised Price Cap simulation. The adoption of these services increases from 22% in 2004 in the Baseline forecast to 56% in the Revised Price Cap simulation. End-to-end ISDN service would increase the transmission rate approximately ten fold, and usership doubles. This rate is fast enough to provide low-quality video. But the real value comes from more routine data transmissions and communications between remote locations and office environments.

Broadband availability increases from 10% in 2004 in the TFI Baseline forecast to 67% in the Revised Price Cap simulation. Adoption increases from 6% in 2004 in the TFI Baseline forecast to 27% in the Revised Price Cap simulation. The additional twenty fold increase in transmission rates allows full motion video and rapid data transmission. The ease of sharing data and information promotes more efficient resource utilization and a reduction in physical transport of people and objects. It also makes remote site working (such as telecommuting) a viable approach to expanding the labor force for some types of activities.

In the Revised Price Cap simulation, quality is assumed to improve along with enhancements in the network. As shown in Table 2, service quality improves 1% in 1995 increasing to a 3% annual improvement by 2004. This yields a cumulative gain of approximately 18% over the ten year interval. This improvement in quality over time is both very conservative given the leaps in speed and reliability that are expected in the PTN and consistent with the TFI projections. In WEFA's models, this quality improvement translates into a comparable increase in the value of telecommunications service to end users.

Table 2
Telecommunications Services
Quality Improvements
in the Revised Price Cap Simulation

Year	Quality Increases (% Change)
1995	1.00
1996	1.22
1997	1.44
1998	1.67
1999	1.89
2000	2.11
2001	2.33
2002	2.56
2003	2.78
2004	3.00

Hedonic characteristics are discussed in numerous articles for a variety of products as a way to gauge pure price change after accounting for quality changes. For example, if the price of an automobile increases slightly due to the availability of air bags, quality (in this case, the safety characteristic) has gone up as well. Thus, the pure price change might be zero net of the quality change while the value to many users has definitely increased.

Another good example is the price of computer technology. Five years ago, a personal computer could have been purchased for $2,500. For that price, the computer included an 8mhz, 16 bit processor, a 40 megabyte hard disk, one megabyte of memory, and a medium-resolution color monitor. Today, a typical personal computer still costs $2,500. However, the package includes a 66mhz, 32 bit processor, a 400 megabyte hard disk, 8 megabytes of memory, and a high resolution color monitor. The price is the same, but the quality is five to ten times higher than it was before. The value to the user has grown at least as much, as the proliferation of personal computering power at work, at home, and while traveling demonstrates. Similar comparisons could be made of computer software applications, which have become more functional and easier to use over time.

The U.S. Department of Commerce, Bureau of Economic Analysis, currently maintains a quality-adjusted, hedonic price index for computer purchases. During the last ten years, this price index has declined 10% to 20% per year, reflecting the tremendous increase in value that users derive from their computer hardware products. This index is used in WEFA's models to denote price change for computer industry output and computer hardware purchases by

consumers, businesses, and governments. The same type of adjustment can be made to other price indexes including telecommunication services.

Technological Change

Network enhancements and service quality improvements result in more rapid adoption of new telecommunications capabilities for a wide variety of purposes. But the use of these new services requires new end-user equipment. The ability to communicate with a desktop or corporate computer from a remote location at over one megabit per second is big step forward in telecommunications capabilities. But it is meaningless if end user equipment only communicates at 1% of that speed.

In the Revised Price Cap simulation, the economy-wide rate of technological change has been increased slightly to account for the productivity gains that enhanced technologies yield. Technology, as a factor of production, supports some amount of economic activity and replaces some amount of labor. So, increases in the rate of technological change boost the long-term growth path of the economy and lowers the labor requirements needed to produce the total output.

As Table 3 indicates, the annual rate of technological change in the U.S. economy is low. Over the next ten years it averages just over one-half of one percent. The incremental gain adds less than 1% to this rate of growth. This implies an additional $1 billion to $5 billion per year in information technology investment throughout the U.S. economy.

Table 3
Technological Change
in the Revised Price Cap Simulation

Year	Baseline Change (Percent)	Incremental Gain (Percent)
1995	0.45	0.0011
1996	0.45	0.0013
1997	0.46	0.0015
1998	0.48	0.0018
1999	0.50	0.0020
2000	0.52	0.0022
2001	0.55	0.0024
2002	0.59	0.0027
2003	0.62	0.0029
2004	0.65	0.0031

WEFA's U.S. ECONOMIC MODEL

OVERVIEW

WEFA's U.S. Economic Model is a quarterly econometric model of the U.S. economy. It is designed for forecasting, policy analysis, and simulation studies. This model is used each month by economists at WEFA to generate the baseline forecast of the U.S. economy as well as to provide alternative forecasts based on varying assumptions on government policies and other external economic, demographic, and policy factors. The model is also used in a wide variety of consulting projects by the WEFA staff. A large number of WEFA clients use WEFA's U.S. Economic Model in their own planning and forecasting activities. Indeed, the Federal Government has relied on WEFA forecasts many times.

WEFA's U.S. Economic Model conforms to neo-Keynesian tradition, with important supply-side and financial influences incorporated in the system to yield a responsive simulation tool. Various income streams drive the components of final demand. The level and mix of output depend on movements in the components of demand. Employment, a major determinant of income, responds to changes in output. Monetary and fiscal conditions and a system of wages, prices, and supply factors interact with these major flows of economic behavior.

The components of demand are modeled from the bottom up using standard approaches which employ various measures of permanent income/output and relative prices. Relative price variables for investment goods incorporate detailed cost of capital specifications, which include a variety of tax policy levers. In addition to detailed consumption, fixed investment, and inventory sectors, the U.S. Economic Model contains fully specified housing, auto, and energy sectors. The model also includes a detailed trade sector in which eight categories (six categories of goods and two categories of services) of both exports and imports are modeled individually. Each is related to appropriate income/demand variables as well as to relative prices. The demand and domestic price variables in the import equations are aligned with the corresponding final demand terms.

Industry-specific input-output weights from the Industrial Analysis Model are applied to the components of spending to construct measures of output produced by each of the 1-digit Standard Industrial Classification (SIC) industry groups. These industry output variables determine labor and capital requirements by industry. The price sector employs a stage-of-processing approach, which starts with unit labor costs and other input prices of determine producer prices. Producer prices are major determinants of the various implicit price deflators, which then finally determine the consumer price indexes. The process is simultaneous, however, since the deflators (along with a measure of labor market tightness) are also determinants of the key wage index via an augmented Phillips curve equation.

The U.S. Economic Model captures important linkages between the financial and real sectors of the economy. Outcomes in the economy affect the federal funds rate through a Federal Reserve reaction function formulation. Long-term interest rates are modeled as functions of short-term interest rates, inflation expectations, and the federal budget deficit. In addition to their impact on the flows of interest payments and receipts, interest rates affect user cost of

capital variables, relative prices of consumer durables, and the consumer sentiment index, all of which influence investment and consumption.

Key fiscal policy levers, demographics, oil and food prices, the real exchange value of the dollar, inflation and growth in the rest of the world, and seasonal patterns are external variables in the model.

MODEL CHARACTERISTICS

From the point of view of forecasting, the absolute size of the Model has important implications. All models represent a compromise between reality and manageability, in that models should be large enough to provide a reasonable representation of the economy and incorporate the main elements of economic activity, but at the same time should be small enough to manage.

The degree of exogeneity, indicated by the number and type of external factors in the Model relative to the number and type of stochastic variables and identities, reflects how much of the forecast is determined by external forces and/or judgment and how much is determined by the internal structure of the Model itself. WEFA's aim is to incorporate as much of the interrelated structure of the economy into the Model as possible.

The Model provides extensive coverage of the U.S. economy. Variables included in the Model are as follows:

- Detailed coverage of the demand-side categories included in the National Income and Product Accounts (NIPA): consumption, investment, government purchases, exports, and imports in both current and constant dollars.

- Price deflators for each of the NIPA categories of demand.

- Detailed components of income and profits from the NIPA.

- NIPA-based measures of government expenditures and receipts by category and level of government. Unified budget measures are also included.

- NIPA-based measures of foreign transactions, as well as measures of rest-of-world growth, inflation, and the trade-weighted value of the dollar.

- Detailed measures of population, labor force, employment, hours, and wage rates as measured by the Bureau of Labor Statistics.

- Detailed financial statistics including interest rates, various measures of the money supply and reserves, consumer credit, and commercial and industrial loans.

- Detailed producer and consumer price indexes as measured by the Bureau of Labor Statistics.